Saline and Alkaline Soils in Czechoslovakia

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The first data on the occurrence of saline soils in Czechoslovak territory were published by the Hungarian agrogeologists TREITZ and HORUSITZKY [19] who, in their agrogeological maps, delineated the so-called alluvial sodic loams.

At the beginning of the 20th century, HORUSITZKY and his collaborators described the saline soils of the Slovak part of the Danubian Lowland in more detail [5, 6, 7]. Since 1930, these soils were studied from the genetic and agronomic standpoints by KYNTERA [12]. The role of underground water in the origin of saline soils in southern Slovakia was studied by CERVENKA [2].

Saline soils in South Moravia were discussed by NOVÁK and MALÁC [14], NOVÁK and HRDINA [15], PELISEK [16, 17] and CERVENKA [4] and they described them as "sulphate-saline soils".

The melioration of saline soils in CSSR and the prognosis of their possible secondary salinization under irrigation were discussed by CERVENKA and LOPATNIK [1, 3, 13].

HRASKO [8, 9, 11] dealt with alkaline soil genesis in the Danubian Lowland and the origin of salts contained in the saline and alkaline soils.

Large-scale soil mapping showed the occurrence and properties of saline and alkaline soils in Czechoslovakia and provided a basis for the solution of some problems on soil genesis and geography. We ascertained that the extent of saline soils was not as large as supposed before. We also established that these soils occurred exclusively on the Sub-Carpathian plains. It was likewise established that the character and degree of salinization in Czechoslovakia varied. We thus decided to describe some of the areas. In Czechoslovak territory we distinguish two types of salinization:

a) sulphatic salinization,
b) sodic salinization.

Consequently, we also distinguish two classes of salt affected soils:

a) saline soils,
b) alkaline soils.

We distinguish three geographical areas of saline and alkaline soils:

1. The dale of Dyje-Svratka (a part of the more extensive basin of Vienna).
2. The Danubian Lowland (part of the more extensive basin of Komárno, of the Little Hungarian Lowland).
3. The East-Slovakian Lowland (part of the more extensive Tisza Lowland, of the Great Hungarian Lowland-Alföld).

1. Saline soils of the Dyje-Svratka dale

Salinization in the Dyje-Svratka dale is mainly from sulphates in the soils or parent rocks. We denoted as saline those soils in which we found water-soluble salt contents exceeding 0.3%. Salinization is observed on marlaceous rocks of the sea Neogene or on flysch marlaceous rocks and also in alluvial positions in river flats.

Larger salt contents occur in the chernozemic soils which developed mainly on marls. However, they also may be observed on loess-derived chernozems, when the loess cover is shallow and lies on marl. In such cases, an increased salt content usually occurs at a depth of 60—100 cm. It forms chernozemic soils with a deep solonchak condition.

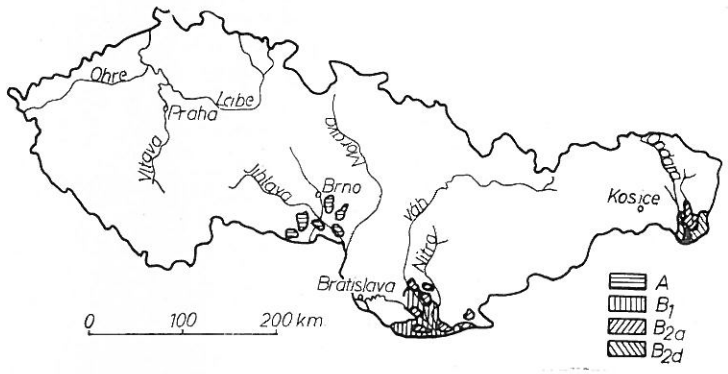

Fig. 1

Salt affected soil in Czehoslovakia. Class A: Saline soils; B: Alkali soils. 1. without structural B horizon; 2. with structural B horizon; a) solonchak-solonetz and calcareous solonetz; d) solonized and slightly salt affected soils with minor structure formation

In the river alluvia salinization is mainly observed in meadow chernozems or meadow soils, but also in some alluvial soils, where the underground water containing sulphates occurs near the surface. According to CERVENKA [4], who analysed underground waters in several localities of this region, sulphates are dominant. Some of the waters also contain bicarbonates and a few of them chlorides. Calcium and particularly magnesium are the dominant cations, while sodium seldom exceeds 10%. Soil salinization on alluvia often reaches the surface layers. The soil reaction does not usually exceed pH 8: no structural differentiation or solonetzic conditions have been observed.

In our opinion, soil salinization in this region is residual, particularly the salinization of parent rocks and chernozemic soils. In the river flats we find mainly secondary salinization due to the capillary rise of groundwater rich in sulphates. Therefore, most of these soils are salt affected to the surface. We suppose that the sulphates were deposited in the rocks at the time of their sedimentation. This is suggested by the presence of sulphatic mineral waters (Saratica) in this region.

2. Saline soils in the Danubian Lowland

We dealt with the nature of soil salinization, in the Slovak part of the Danubian Lowland at the Symposium on sodic salinization in 1964 in Budapest [10]. In these soils salinization is not so intensive as in others but there is some structural differentiation of the profiles exhibiting high contents of sorbed sodium. In some extreme cases, the exchange complex is saturated with sodium.

In the Danubian Lowland sodic salinization is dominant and the soil reaction is very high (above pH 9). A further feature of these soils is that they are usually carbonaceous from the surface and in the lower profile the carbonate content exceeds 20%. The amount of salts determined from the water extracts (evaporated at 105 °C), in the upper horizons usually does not exceed 0.4%. The solonetzic meadow and alluvial soils, in general, have 5—20% sorbed sodium and the meadow solonetz-solonchaks 20 - 57%.

Soil salinization in the Danubian Lowland is primarily observed in the Danube's strongly carbonaceous alluvia, but it also occurs in loesses deposited in former water reservoirs (HORUSITZKY). A further characteristic of these soils is that they do not occur over large areas. They are found in small areas within the surrounding soils.

In the above mentioned work [10], we divided this region of salt affected soils into 3 districts.

The first district in the Danubian Lowland is especially characterized by its discontinuous nature. This salinization is characterized by the presence of basic meadow solonetz-solonchaks and meadow and alluvial soils, solonchaked and solonetzed to various degrees, occurring in a complex with carbonaceous meadow and alluvial soils. These meadow and alluvial soils too, are characterized by their high content of carbonates (attaining often more than 10% at the surface). The pH of the meadow and alluvial soils ranges from 7.8—8.3.

The second district is characterized by a more continuous distribution of solonetzic-solonchaked soils, and lies in the Vág and Nitra rivers alluvia, and above all, on loess sedimented in former bogs.

The third district is represented by meadow and alluvial solonetzic-solonchaked soils on the layered alluvium of the Hron river. In contrast to the soils of the other districts, these have a relatively low carbonate content, a pH of about 8, and a relative predominance of sulphates and chlorides in water extracts. SZABOLCS [21] emphasizes that the soils of this region belong to neither the solonetz nor the solonchak type, even if the content of salt and exchangeable sodium is high. This district of saline soils coincides by its morphological structure with the saline soils of the lake Fertő region, near the Austro—Hungarian frontier.

3. Saline soils of the East-Slovakian Lowland

These saline soils are more or less continuous over loessial deposits and alluvial sediments of the Laborec, Latorica, Ondava and Bodrog rivers. On the loess sediments they are solonetzic soils with well developed structural horizons, but on the alluvia they are mainly saline-solonchak soils.

These soils vary from slightly solonetzic meadow and meadow-chernozemic soils to typical crusty solonetzes which occur in combination with meadow chernozems. The salt content of these solonetzes is relatively low and consists of bicarbonates, chlorides and sulphates. In these soils there is far less soda than in those of the Danubian Lowland. The textural solonetzic horizon is generally just below the soil surface (crusty solonetz), but there are cases where the illuvial horizon lies deeper than 40 cm. Due to water-impermeability, the soil surface often becomes acidified and solodization occurs. SZABOLCS [18] remarks that this form of salinization is also found in the Tisza river basin. He considers the solodized solonetzes of this region to be genetically related with some similar soils of the Hortobágy region in Hungary.

Solonchakedness, i.e. salinization without any structural differentiation of the profiles, is only observed in alluvial soils though with deeper groundwater we sometimes find structural differentiation in the profile. Since there are relatively few of these soils and all of them have heavy mechanical composition and gley processes in the lower profile (especially in the mother rocks), we include all soils of the East-Slovakian Lowland in the group of solonetzic-solonchaked alkaline soils. However, we separate them into a special geographical region because in contrast to similar soils in the Danubian Lowland they originated on rocks having a slight content of carbonate and because they show some solodization which has not been found in the Danubian Lowland.

Summary

The saline soils in CSSR are divided in two types of salinization and according to their geographical distribution, into three regions.

Saline soils without structural differentiation of the profile occur only in the Dyje-Svratka dale region, in South Moravia, where we find residual-salinized chernozems on Neogene marls (salinization merely in the parent rock), and secondarily salinized meadow and alluvial soils which often contain salts to their surface. In both cases the character of salinization is a sulphatic one.

Sodic salinization is most intense in the Danubian Lowland. These alkaline soils have the highest pH of all saline soils of CSSR. We mainly find them as meadow or solonetzic-solonchaked soils in complexes with salinized meadow and alluvial soils. On loess covers we find typical meadow solonchak-solonetzes.

Sodic salinization occurs in the East-Slovakian Lowland soils, but there we often observe solodization which results in acidification of the surface layer of soil. Solonetzic-solonchaked soils are found in this region on loessial covers in combination with meadow chernozems and on the river alluvia. In this latter case the solonetzic condition is less developed, but the salt content is higher than in loess.

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